OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **Cobbetts Pond, Windham,** the program coordinators have made the following observations and recommendations.

Thank you for your continued hard work sampling the pond this year! Your monitoring group sampled the deep spot **three** times this year! Conducting multiple sampling events each year enables DES to more accurately detect water quality changes. We hope you continue to sample the pond three times each summer, typically June, July, and August. Keep up the good work!

DES performed a survey of variable milfoil growth in Cobbetts Pond in spring 2010 and found a few small patches of growth. Thanks to local residents sending in information about new growth DES divers were guided to areas where hand-removal efforts were needed. DES spent a few days diving and using the Diver-Assisted Suction Harvesting unit to remove patches of variable milfoil from a few shoreline areas and in the area of the narrows in the middle of the lake. Also in 2010, the small marina area on the western shoreline was treated with an aquatic herbicide to reduce dense growths of the plant in that area. DES plans to survey Cobbetts Pond again in spring 2011, and has divers on call to perform more work as needed. When the ice goes out please do continue to survey for milfoil growth and report any suspicious growth to Amy Smagula at Amy.Smagula@des.nh.gov.

Watershed Management Plan
The Cobbetts Pond watershed is heavily developed, lies entirely within the Town of Windham and includes 14 sub-watersheds. The pond itself is completely surrounded be residential roads with a second tier of transportation corridors including Route 111, Route 111A, Cobbetts Pond Road and I-93. Since the 1980s, the water quality has shifted rapidly from Oligotrophic to Eutrophic due to cultural eutrophication. As a result of the trophic shift, Cobbetts Pond is listed as impaired for dissolved oxygen saturation, which causes a failure to support the aquatic life use designation.

In 2008, the Cobbetts Pond Improvement Association (CPIA) applied to DES for EPA Section 319 restoration grant funding to develop a watershed management plan addressing pollutant loads causing the water quality impairment. The CPIA was awarded $83,000 to collect additional water quality data and develop the watershed management plan. One of the priority sites identified by the Geosyntec, the consultant contracted to develop the watershed management plan, for reducing sediment and nutrient loads to Cobbetts Pond was the Fossa Rd. subwatershed, located on the south west side of the pond.

I-93, Rte. 111, and Rte. 111A Construction, Windham

In December, 2008, the contractor for the NH Department of Transportation I-93, 13933K Project, did not implement necessary sediment and erosion controls, leading to a violation of state water quality standards. As a result, the State and contractor entered into a Consent Decree to provide for the resolution of the State's claims for injunctive relief and civil penalties against the contractor for alleged violations of the New Hampshire Water Pollution and Waste Disposal Act (RSA chapter 485-A), for alleged violations of the New Hampshire Fill and Dredge in Wetlands Act (RSA chapter 482-A), and for the alleged failure to meet specified contracting requirements on certain property located at Exit 3 on I-93 in Windham.

The settlement of the above claims resulted in construction of stormwater treatment measures, including streambank stabilization and stormwater detention within the degraded intermittent stream to allow for settling and sediment capture at the Fossa Road priority site. NH DOT and the landowner, Bill Day, signed a maintenance agreement to support ongoing maintenance and functionality of the stormwater treatment system.

Geosyntec, the environmental consultant and design engineer for the project, estimates that 4.7 tons of sediment and 12.1 lbs of phosphorus will be captured by the stormwater treatment system annually. This represents approximately 8 percent of the annual phosphorus load reduction identified in the Cobbetts Pond Watershed Management Plan. See http://projects.geosyntec.com/BW0131/Documents/Cobbetts_WRP_07062010.pdf for a copy of the management plan.

FIGURE INTERPRETATION

CHLOROPHYLL-A

- **Figure 1 and Table 1:** Figure 1 in Appendix A depicts the historical and current year chlorophyll-a concentration in the water column. Table 1 in Appendix B lists the minimum, maximum, and mean concentration for each year that the pond has been monitored through VLAP.

Chlorophyll-a, a pigment found in plants, is an indicator of the algal abundance. Algae (also known as phytoplankton) are typically microscopic, chlorophyll producing plants that naturally occur in lake ecosystems. The chlorophyll-a concentration measured in the water gives biologists an estimation of the algal concentration or lake productivity. **The median summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 4.58 mg/m³.**

STATION 1
The current year data (the top graph) show that the chlorophyll-a concentration ***increased slightly*** from **May** to **July**.

Please note the April chlorophyll-a sample was not analyzed due to a laboratory error. We apologize for any inconvenience.

The historical data (the bottom graph) show that the **2010** chlorophyll-a mean is ***slightly less than*** the state median and is ***greater than*** the similar lake median. For more information on the similar lake median, refer to Appendix F.

Overall, the statistical analysis of the historical data shows that the chlorophyll-a concentration has ***significantly increased*** (meaning ***worsened***) on average by ***approximately 3.39 percent*** per year during the sampling period **1988** to **2010**. Please refer to Appendix E for the statistical analysis explanation and data print-out.

STATION 2
The current year data (the top graph) show that the chlorophyll-a concentration ***increased greatly*** from **May** to **July**.

Please note the April chlorophyll-a sample was not analyzed due to a laboratory error. We apologize for any inconvenience.

The historical data (the bottom graph) show that the **2010** chlorophyll-a mean is ***much greater than*** the state and similar lake medians. For more information on the similar lake median, refer to Appendix F.

Overall, the statistical analysis of the historical data shows that the chlorophyll-a concentration has ***significantly increased*** (meaning ***worsened***) on average by ***approximately 3.18 percent*** per year during the sampling period **1988** to **2010**. Please refer to Appendix E for the statistical analysis explanation and data print-out.

While algae are naturally present in all lakes and ponds, an excessive or increasing amount of any type is not welcomed. In freshwater lakes and ponds, phosphorus is the nutrient that algae typically depend upon for growth in New Hampshire lakes. Algal concentrations may increase as nonpoint sources of phosphorus from the watershed increase, or as in-lake phosphorus sources increase. Therefore, it is extremely important for volunteer monitors to continually educate all watershed residents about management practices that can be implemented to minimize phosphorus loading to surface waters.

TRANSPARENCY

- **Figure 2 and Tables 3a and 3b:** Figure 2 in Appendix A shows the historical and current year data for transparency with and without the use of a viewscope. Table 3a in Appendix B lists the minimum, maximum and mean transparency data without the use of a viewscope and Table 3b lists the minimum, maximum and mean transparency data with the use of a viewscope for each year that the pond has been monitored through VLAP.

  Volunteer monitors use the Secchi disk, a 20 cm disk with alternating black and white quadrants, to measure how far a person can see into the water. Transparency, a measure of water clarity, can be affected by the amount of algae and sediment in the water, as well as the natural lake color of the water. **The median summer transparency for New Hampshire's lakes and ponds is 3.2 meters.**

  STATION 1
  The current year data (the top graph) show that the non-viewscope in-lake transparency ***increased*** from **April** to **May**, and then ***decreased slightly*** from **May** to **July**.

  The historical data (the bottom graph) show that the **2010** mean non-viewscope transparency is ***slightly greater than*** state median and is ***less than*** the similar lake median. Please refer to Appendix F for more information about the similar lake median.

  The current year data (the top graph) show that the viewscope in-lake transparency ***increased*** from **April** to **May**, and then ***decreased slightly*** from **July** to **August**. The transparency measured with the viewscope was generally ***greater than*** the transparency measured without the viewscope this summer. A comparison of the transparency readings taken with and without the use of a viewscope shows that the viewscope typically increases the depth to which the Secchi disk can be seen into the lake, particularly on sunny and windy days. We recommend that your group measure Secchi disk transparency with and without the viewscope on each sampling event.

It is important to note that viewscope transparency data are not compared to a New Hampshire median or similar lake median. This is because lake transparency with the use of a viewscope has not been historically measured by DES. At some point in the future, the New Hampshire and similar lake medians for viewscope transparency will be calculated and added to the appropriate graphs.

Overall, the statistical analysis of the historical data shows that the non-viewscope transparency has ***significantly decreased*** (meaning ***worsened***) on average by ***approximately 1.99 percent*** per year during the sampling period **1988**to **2010**. Please refer to Appendix E for the statistical analysis explanation and data print-out.

STATION 2
The current year data (the top graph) show that the non-viewscope in-lake transparency ***increased*** from **April** to **July**.

The current year data (the top graph) show that the viewscope in-lake transparency ***increased*** from **April** to **July**. The transparency measured with the viewscope was generally ***greater than*** the transparency measured without the viewscope this summer. A comparison of the transparency readings taken with and without the use of a viewscope shows that the viewscope typically increases the depth to which the Secchi disk can be seen into the lake, particularly on sunny and windy days. We recommend that your group measure Secchi disk transparency with and without the viewscope on each sampling event.

It is important to note that viewscope transparency data are not compared to a New Hampshire median or similar lake median. This is because lake transparency with the use of a viewscope has not been historically measured by DES. At some point in the future, the New Hampshire and similar lake medians for viewscope transparency will be calculated and added to the appropriate graphs.

Overall, the statistical analysis of the historical data shows that the non-viewscope transparency has ***significantly decreased*** (meaning ***worsened***) on average by ***approximately 1.51 percent*** per year during the sampling period **1988**to **2010**. Please refer to Appendix E for the statistical analysis explanation and data print-out.

Typically, high intensity rainfall causes sediment-laden stormwater runoff to flow into surface waters, thus increasing turbidity and decreasing clarity. Efforts to stabilize stream banks, lake and pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake or pond should continue on an annual basis. Guides to best management practices that can be implemented to reduce, and possibly even eliminate, nonpoint source pollutants, are available from DES upon request.

TOTAL PHOSPHORUS

- **Figure 3 and Table 8:** The graphs in Figure 3 in Appendix A show the amount of epilimnetic (upper layer) phosphorus and hypolimnetic (lower layer) phosphorus; the inset graphs show current year data. Table 8 in Appendix B lists the annual minimum, maximum, and median concentration for each deep spot layer and each tributary since the pond has been sampled through VLAP.

  Phosphorus is typically the limiting nutrient for vascular aquatic plant and algae growth in New Hampshire's lakes and ponds. Excessive phosphorus in a lake or pond can lead to increased plant and algal growth over time. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 12 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

  STATION 1
  The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration ***decreased gradually*** from **April** to **July**.

  The ***elevated*** epilimnetic phosphorus concentration measured on the **April** sampling event was a result of phosphorus-enriched stormwater runoff that flowed into the surface layer of the pond from watershed construction activities. Weather records indicate that approximately **5.0 inches** of rain fall was measured **24-72 hours** prior to sampling.

  The historical data show that the **2010** mean epilimnetic phosphorus concentration is ***slightly greater than*** the state median and is ***greater than*** the similar lake median. Refer to Appendix F for more information about the similar lake median.

  The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***increased gradually*** from **April** to **July**.

  The historical data show that the **2010** mean hypolimnetic phosphorus concentration is ***slightly greater than*** state and similar lake medians. Please refer to Appendix F for more information about the similar lake median.

Overall, the statistical analysis of the historical data shows that the epilimnetic (upper layer) phosphorus concentration has ***significantly increased*** (meaning ***worsened***) on average by ***approximately 3.40 percent*** per year during the sampling period **1988** to **2010**. Please refer to Appendix E for the statistical analysis explanation and data print-out.

Overall, the statistical analysis of the historical data shows that the hypolimnetic (lower layer) phosphorus concentration has ***significantly increased*** (meaning ***worsened***) on average at a rate of ***approximately*** **4.0 percent** per year during the sampling period **1988** to **2010**. Please refer to Appendix E for the statistical analysis explanation and data print-out.

STATION 2

The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration ***decreased gradually*** from **April** to **July**.

The ***elevated*** epilimnetic phosphorus concentration measured on the **April** sampling event was a result of phosphorus-enriched stormwater runoff that flowed into the surface layer of the pond from watershed construction activities. Weather records indicate that approximately **5.0 inches** of rain fall was measured **24-72 hours** prior to sampling.

The historical data show that the **2010** mean epilimnetic phosphorus concentration is ***slightly less than*** the state median and is ***greater than*** the similar lake median. Refer to Appendix F for more information about the similar lake median.

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***increased gradually*** from **April** to **July**.

The hypolimnetic (lower layer) turbidity sample was ***elevated*** on the **July** sampling event (**3.84 NTUs**). This suggests that the pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling and/or that the pond bottom is covered by an easily disturbed thick organic layer of sediment. When the pond bottom is disturbed, phosphorus rich sediment is released into the water column. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

The historical data show that the **2010** mean hypolimnetic phosphorus concentration is ***greater than*** state and similar lake medians. Please refer to Appendix F for more information about the similar lake median.

Overall, the statistical analysis of the historical data shows that the epilimnetic (upper layer) phosphorus concentration has ***significantly increased*** (meaning ***worsened***) on average by ***approximately 3.25 percent*** per year during the sampling period **1988** to **2010**. Please refer to Appendix E for the statistical analysis explanation and data print-out.

Overall, the statistical analysis of the historical data shows that the hypolimnetic (lower layer) phosphorus concentration has ***significantly increased*** (meaning ***worsened***) on average at a rate of ***approximately* 5.40 percent** per year during the sampling period **1988** to **2010**. Please refer to Appendix E for the statistical analysis explanation and data print-out.

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about the watershed sources of phosphorus and how excessive phosphorus loading can negatively impact the ecology and the recreational, economical, and ecological value of lakes and ponds.

TABLE INTERPRETATION

- **Table 2: Phytoplankton**
  Table 2 in Appendix B lists the current and historical phytoplankton and/or cyanobacteria observed in the pond. Specifically, this table lists the three most dominant phytoplankton and/or cyanobacteria observed in the sample and their relative abundance in the sample.

STATION 1
The dominant phytoplankton and/or cyanobacteria observed in the **April** sample were ***Synedra* (Diatom)**, ***Rhizosolenia* (Diatom)**, and ***Dinobryon* (Golden-Brown)**.

The dominant phytoplankton and/or cyanobacteria observed in the **May** sample were ***Anabaena* (Cyanobacteria)**, ***Ceratium* (Dinoflagellate)**, and ***Asterionella* (Diatom)**.

The dominant phytoplankton and/or cyanobacteria observed in the **July** sample were ***Anabaena* (Cyanobacteria)**, ***Fragilaria* (Diatom)**, and ***Asterionella/Ceratium* (Diatom/Dinoflagellate)**.

STATION 2
The dominant phytoplankton and/or cyanobacteria observed in the **April** sample were ***Dinobryon* (Golden-Brown)**, ***Rhizosolenia* (Diatom)**, and ***Synedra* (Diatom)**.

The dominant phytoplankton and/or cyanobacteria observed in the **May** sample were ***Anabaena* (Cyanobacteria)**, ***Asterionella* (Diatom)**, and ***Ceratium* (Dinoflagellate)**.

The dominant phytoplankton and/or cyanobacteria observed in the **July** sample were ***Anabaena* (Cyanobacteria)**, ***Fragilaria* (Diatom)**, and ***Ceratium* (Dinoflagellate)**.

Phytoplankton populations undergo a natural succession during the growing season. Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession. Diatoms and golden-brown algae populations are typical in New Hampshire's less productive lakes and ponds.

- **Table 2: Cyanobacteria**
  A **large amount** of the cyanobacterium ***Anabaena*** was observed in the **May** and **July** plankton samples. ***This cyanobacterium, if present in large amounts, can be toxic to livestock, wildlife, pets, and humans***. Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding cyanobacteria.

  Cyanobacteria can reach nuisance levels when phosphorus loading from the watershed to surface waters is increased and favorable environmental conditions occur, such as a period of sunny, warm weather.

  The presence of cyanobacteria serves as a reminder of the pond's delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading to the pond by eliminating lawn fertilizer use, keeping the pond shoreline natural, re-vegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

  In addition, residents should also observe the pond in September and October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface in high concentrations. Wind and currents tend to "pile" cyanobacteria into scums that accumulate in one section of the pond. If a fall bloom occurs, please collect a sample in any clean jar or bottle and contact the VLAP Coordinator.

- **Table 4: pH**
  Table 4 in Appendix B presents the in-lake and tributary current year and historical pH data.

  pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 6.0 typically limits the growth and reproduction of fish. A pH between 6.0 and 7.0 is ideal for fish. The median pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.6**, which indicates that the state surface waters are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

  The mean pH at the **Station 1** deep spot ranged from **6.81** in the hypolimnion to **7.41** in the epilimnion. The mean pH at the **Station 2** deep spot ranged from **6.80** in the hypolimnion to **7.30** in the epilimnion. This means that the hypolimnion is ***slightly acidic***, and the epilimnion is ***slightly basic***.

  It is important to point out that the hypolimnetic (lower layer) pH was ***lower (more acidic)*** than in the epilimnion (upper layer). This increase in acidity near the pond bottom is likely due to the decomposition of organic matter and the release of acidic by-products into the water column.

- **Table 5: Acid Neutralizing Capacity**
  Table 5 in Appendix B presents the current year and historical epilimnetic ANC for each year the pond has been monitored through VLAP.

  Buffering capacity (ANC) describes the ability of a solution to resist changes in pH by neutralizing the acidic input. The median ANC value for New Hampshire's lakes and ponds is **4.8 mg/L**, which indicates that many lakes and ponds in the state are at least "moderately vulnerable" to acidic inputs. For a more detailed explanation about ANC, please refer to the "Chemical Monitoring Parameters" section of this report.

  The mean acid neutralizing capacity (ANC) of the **Station 1** epilimnion (upper layer) was **19.3 mg/L**. The mean ANC of the

Station 2 epilimnion was **21.4 mg/L**. This is ***much greater than*** the state median. In addition, this indicates that the pond has a ***low vulnerability*** to acidic inputs.

- **Table 6: Conductivity**

Table 6 in Appendix B presents the current and historical conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current, which is determined by the number of negatively charged ions from metals, salts, and minerals in the water column. The median conductivity value for New Hampshire's lakes and ponds is **40.0 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean annual epilimnetic conductivity at the **Station 1** and **Station 2** deep spots was **267.7 uMhos/cm**. This is ***much greater than*** the state median.

The conductivity continued to remain ***much greater than*** the state median in the pond and tributaries this year. Typically, elevated conductivity indicates the influence of pollutant sources associated with human activities. These sources include failed or marginally functioning septic systems, agricultural runoff, and road runoff, which contain road salt during the spring snow-melt. New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could also contribute to increasing conductivity. In addition, natural sources, such as iron and manganese deposits in bedrock, can influence conductivity.

We recommend that your monitoring group conduct stream surveys and rain event sampling along the tributaries with ***elevated*** conductivity so that we can determine what may be causing the increases.

For a detailed explanation on how to conduct rain event sampling and stream surveys, please refer to the 2002 VLAP Annual Report special topic article, which is posted on the VLAP website at ***http://www.des.nh.gov/organization/divisions/water/wmb/vlap/categories/publications.htm****, or contact the VLAP Coordinator.*

It is likely that de-icing materials applied to nearby roadways during the winter months may be influencing the conductivity in the pond. The most commonly used de-icing material in New Hampshire is salt (sodium chloride).

A limited amount of chloride sampling was conducted during ***2010****. Please refer to the discussion of* ***Table 13*** *for more information.*

Therefore, we recommend that the **epilimnion** and the **tributaries** be sampled for chloride next year. This additional sampling may help us identify what areas of the watershed are contributing to the increasing in-lake conductivity.

Please note that the DES Limnology Center in Concord is able to conduct chloride analyses, free of charge. As a reminder, it is best to conduct chloride sampling in the spring as the snow is melting and during rain events.

- **Table 8: Total Phosphorus**
  Table 8 in Appendix B presents the current year and historical total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the ability of algae and aquatic plants to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The phosphorus concentration was ***relatively low*** at **Armstrong, Bella Vista, Community Beach, Connie's Brook, Connie's Brook at 111, Main Inlet, Monson Inlet, Mueller Stream, and the Town Beach**, which is good news. However, we recommend that your monitoring group sample the major tributaries to the pond during snow-melt and periodically during rainstorms to determine if the phosphorus concentration is ***elevated*** in the tributaries during these times. Typically, the majority of nutrient loading to a pond occurs in the spring during snow-melt and during intense rainstorms that cause soil erosion and surface runoff and within the watershed.

  For a detailed explanation on how to conduct rain event sampling and stream surveys, please refer to the 2002 VLAP Annual Report special topic article, which is posted on the VLAP website at ***http://www.des.nh.gov/organization/divisions/water/wmb/vlap/categories/publications.htm****, or contact the VLAP Coordinator.*

  The total phosphorus concentration was ***elevated*** (**67 ug/L**) in **Fossa Rd Inlet** on the **April** sampling event. The turbidity of the sample was also ***slightly elevated*** (**1.72 NTUs**).

  The total phosphorus concentration was ***elevated*** (**58 ug/L**) in **Dinsmore Brook** on the **April** sampling event. The turbidity of the sample was also ***elevated*** (**15.4 NTUs**).

  A significant storm event resulted in approximately **5.0 inches** of rainfall in the **24-72 hours** prior to the **April** sampling event. In addition, large-scale watershed construction activities altered run-off patterns and were not equipped to handle increased stormwater volumes. This resulted in sediment-laden stormwater being discharged to several tributaries and ultimately the pond.

For a detailed explanation on how to conduct rain event sampling and stream surveys, please refer to the 2002 VLAP Annual Report special topic article, which is posted on the VLAP website at ***http://www.des.nh.gov/organization/divisions/water/wmb/vlap/categories/publications.htm****, or contact the VLAP Coordinator.*

Additional phosphorus sampling was conducted at the Station 1 and Station 2 deep spots in April. This sampling was conducted to determine if the phosphorus concentration was elevated prior to the pond "turnover" in the spring. Phosphorus concentrations were slightly elevated in the upper water column, but decreased toward the pond bottom. This is good news and indicates that the phosphorus concentration in the pond decreases during the dormant winter period.

- **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**
  Table 9 in Appendix B shows the dissolved oxygen/temperature profile(s) collected during **2010**. Table 10 in Appendix B shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of sufficient amounts of dissolved oxygen in the water column is vital to fish and amphibians and bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The dissolved oxygen concentration was ***high*** at all **Station 1** and **Station 2** deep spot depths sampled at the pond on the **April** sampling event. The April sampling event occurred prior to spring "turnover" of the pond and we expect to see oxygen well circulated throughout the water column during this period.

  As the pond became thermally stratified during the summer months, the dissolved oxygen concentration was ***depleted in the hypolimnion (lower layer)*** at the **Station 1** and **Station 2** deep spots on the **May and July** sampling events. As stratified ponds age, and as the summer progresses, oxygen typically becomes ***depleted*** in the hypolimnion by bacterial decomposition. Specifically, the reduction of hypolimnetic oxygen is primarily a result of biological organisms using oxygen to break down organic matter, both in the water column and particularly at the bottom of the lake or pond where the water meets the sediment. When the hypolimnetic oxygen concentration is depleted to less than 1 mg/L, the phosphorus that is normally bound up in the sediment may be re-released into the water column, a process referred to as ***internal phosphorus loading***.

The dissolved oxygen concentration was greater than **100 percent** saturation between **0.1** and **7.0** meters at the **Station 1** deep spot, and between **0.1** and **4.0** meters at the **Station 2** deep spot on the **April** sampling event. Wave action from wind can dissolve atmospheric oxygen into the upper layers of the water column. Layers of algae can also increase the dissolved oxygen in the water column, since oxygen is a by-product of photosynthesis. Considering that the depth of sunlight penetration into the water column was approximately **3.0** meters on this sampling event, as shown by the Secchi disk transparency depth, we suspect that an abundance of algae in the epilimnions caused the oxygen super-saturation.

The dissolved oxygen concentration was ***greater than*** **100 percent** saturation at **0.1** meters, and between **3.0** and **4.0** meters at the **Station 1** deep spot on the **May** sampling event. The dissolved oxygen concentration was also ***greater than*** **100 percent saturation** between **0.1** and **1.0** meters, and between **5.0** and **6.0** meters at the **Station 1** deep spot on the **July** sampling event. This suggests that wind and wave action may have contributed to the saturation spike at the water's surface and that a layer of algae contributed further down in the water column.

The dissolved oxygen concentration was ***greater than*** **100 percent saturation** between **0.1** and **4.0** meters at the **Station 2** deep spot on the **May** sampling event. The dissolved oxygen concentration was also ***greater than*** **100 percent saturation** between **0.1** and **6.0** meters at the **Station 2** deep spot on the **July** sampling event. Considering that the depth of sunlight penetration into the water column was approximately **3.25** and **4.75** meters on these sampling events, as shown by the Secchi disk transparency depth, we suspect that an abundance of algae in the epilimnion caused the oxygen super-saturation.

- **Table 11: Turbidity**

Table 11 in Appendix B lists the current year and historical data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the "Other Monitoring Parameters" section of this report for a more detailed explanation.

As discussed previously, the **Station 2** hypolimnetic (lower layer) turbidity was ***slightly elevated*** (**3.84 NTUs**) on the **July** sampling event. In addition, the hypolimnetic turbidity has been elevated on many sampling events during previous sampling years. This suggests that the pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling and/or that the lake bottom is covered by an easily disturbed, thick organic layer of sediment. When the pond bottom is disturbed, phosphorus rich sediment is released into the water column. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

The turbidity of the **Station 1** and **Station 2** epilimnion (upper layer) samples was ***elevated*** (**1.40** and **1.45 NTUs**) on the **April** sampling event. The significant storm event prior to the April sampling contributed stormwater runoff to the lake likely causing the elevated turbidity levels.

The turbidity in the **Dinsmore Brook, Fossa Rd Inlet and Main Inlet at Castleton Brook** samples was ***elevated*** (**15.4, 1.72 and 2.67 NTUs**) on the **April** sampling event.

A significant storm event resulted in approximately **5.0 inches** of rainfall in the **24-72 hours** prior to the **April** sampling event. In addition, large-scale watershed construction activities altered run-off patterns and were not equipped to handle increased stormwater volumes. This resulted in sediment-laden stormwater being discharged to several tributaries and ultimately the pond.

- **Table 12: Bacteria (*E.coli*)**
  Table 12 in Appendix B lists the current year and historical data for bacteria (*E.coli*) testing. *E. coli* is a normal bacterium found in the large intestine of humans and other warm-blooded animals. *E.coli* is used as an indicator organism because it is easily cultured and its presence in the water, in defined amounts, indicates that sewage **may** be present. If sewage is present in the water, potentially harmful disease-causing organisms **may** also be present.

  The *E.coli* concentration was **low** on each sampling event at each of the sites tested this year. We hope this trend continues!

  If residents are concerned about sources of bacteria, such as failing septic systems, animal waste, or waterfowl waste, it is best to conduct *E. coli* testing when the water table is high, when beach use is heavy, or immediately after rain events.

- **Table 13: Chloride**
  Table 13 in Appendix B lists the current year and the historical data for chloride sampling. The chloride ion (Cl^-) is found naturally in some surfacewaters and groundwaters and in high concentrations in

seawater. Research has shown that elevated chloride levels can be toxic to freshwater aquatic life. In order to protect freshwater aquatic life in New Hampshire, the state has adopted **acute and chronic** chloride criteria of **860 and 230 mg/L** respectively. The chloride content in New Hampshire lakes is naturally low, generally less than 2 mg/L in surface waters located in remote areas away from habitation. Higher values are generally associated with salted highways and, to a lesser extent, with septic inputs. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

The **Station 1** and **Station 2 epilimnions** were sampled for chloride during the **April, May and July** sampling events. The **Station 1** results were **47, 52 and 55 mg/L**. The Station 2 results were **51 and 52 mg/L**. These are ***less than*** the state acute and chronic chloride criteria. However, this concentration is ***much greater than*** what we would normally expect to measure in undisturbed New Hampshire surface waters.

The **Armstrong** tributary was sampled for chloride on the **April and May** sampling events. The results were **40 and 68 mg/L**, which is ***less than*** the state acute and chronic chloride criteria.

The **Community Beach** tributary was sampled for chloride on the **April and May** sampling events. The results were **36 and 52 mg/L**, which is ***less than*** the state acute and chronic chloride criteria.

Connie's Brook was sampled for chloride on the **April and May** sampling events. The results were **41 and 73 mg/L**, which is ***less than*** the state acute and chronic chloride criteria.

Connie's Brook at 111 was sampled for chloride on the **May** sampling event. The result was **30 mg/L**, which is ***less than*** the state acute and chronic chloride criteria.

Dinsmore Brook was sampled for chloride on the **April and May** sampling events. The results were **55 and 110 mg/L**, which is ***less than*** the state acute and chronic chloride criteria.

Fossa Rd Inlet was sampled for chloride on the **April and May** sampling events. The results were **63 and 65 mg/L**, which is ***less than*** the state acute and chronic chloride criteria.

The **Main Inlet at Castleton Brook** was sampled for chloride on the **April and May** sampling events. The results were **49 and 91 mg/L**, which is ***less than*** the state acute and chronic chloride criteria.

Monson Inlet was sampled for chloride on the **April** sampling event. The result was **55 mg/L**, which is ***less than*** the state acute and chronic chloride criteria.

Mueller Stream was sampled for chloride on the **April and May** sampling events. The results were **46 and 77 mg/L**, which is ***less than*** the state acute and chronic chloride criteria.

The **Town Beach** tributary was sampled for chloride on the **April and May** sampling events. The results were **52 and 53 mg/L**, which is ***less than*** the state acute and chronic chloride criteria.

We recommend that your monitoring group conduct chloride sampling in the epilimnion at the deep spots and in the tributaries near salted roadways, particularly in the spring, during snow-melt and rain events during the summer. This will establish a baseline of data that will assist your monitoring group and DES to determine lake quality trends in the future.

Please note that chloride analyses can be run free of charge at the DES Limnology Center. Please contact the VLAP Coordinator if you are interested in chloride monitoring. In addition, it is best to conduct chloride sampling in the spring as the snow is melting and during rain events.

In addition, if your group is concerned about salt use on a particular roadway, we recommend contacting the town road agent or the Department of Transportation to discuss the implementation of a low-salt area near the lake and/or its major tributaries. We also recommend that your group work with watershed residents to reduce the application of chloride containing de-icing agents to driveways and walkways.

To learn more about conductivity and chloride pollution and what can be done about to minimize it, please refer to the 2004 VLAP Annual Report special topic article, which is posted on the VLAP website at ***http://www.des.nh.gov/organization/divisions/water/wmb/vlap/categories/publications.htm****, or contact the VLAP Coordinator.*

- **Table 14: Current Year Biological and Chemical Raw Data**
  Table 14 in Appendix B lists the most current sampling year results. Since the maximum, minimum, and annual mean values for each parameter are not shown on this table, this table displays the current year "raw," meaning unprocessed, data. The results are sorted by station, depth, and then parameter.

- **Table 15: Station Table**
  As of the spring of 2004, all historical and current year VLAP data are included in the DES Environmental Monitoring Database (EMD). To facilitate the transfer of VLAP data into the EMD, a new station identification system had to be developed. While volunteer monitoring groups can still use the sampling station names that they have used in the past and are most familiar with, an EMD station name also exists for each VLAP sampling location. Table 15 in Appendix B identifies what EMD station name corresponds to the station names you have used in the past and will continue to use in the future.

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit:

During the annual visits to your pond, the biologist conducted a sampling procedures assessment audit for your monitoring group. Specifically, the biologist observed the performance of your monitoring group and completed an assessment audit sheet to document the volunteer monitors' ability to follow the proper field sampling procedures, as outlined in the VLAP Monitor's Field Manual. This assessment is used to identify any aspects of sample collection in which volunteer monitors failed to follow proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure samples that the volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group performed ***very well*** while collecting samples on the annual biologist visit this year! Specifically, the members of your monitoring group followed the majority of the proper field sampling procedures. However, the biologist did identify a few aspects regarding sample collection that the volunteer monitors could improve upon, as follows:

- **Anchoring at deep spot:** Please remember to use an anchor with sufficient weight and a sufficient amount of rope to prevent the boat from drifting while sampling at the deep spot. It is difficult for the biologist to collect an accurate and representative dissolved oxygen/temperature profile when the boat is drifting. In addition, it is difficult to view the Secchi disk and collect samples from the proper depths when the boat is drifting. Depending on the depth of the pond and the wind conditions, it may be necessary to use two anchors!

USEFUL RESOURCES

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, DES Booklet WD-03-42, (603) 271-2975 or
www.des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-03-42.pdf.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, DES fact sheet WMB-10, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-10.pdf.

How to Identify Cyanobacteria, DES Pamphlets & Brochures, (603) 271-2975 or
http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/cyano_id_flyer.pdf

Low Impact Development Hydrologic Analysis. Manual prepared by Prince George's County, Maryland, Department of Environmental Resources. July 1999. To access this document, visit www.epa.gov/owow/nps/lid_hydr.pdf or call the EPA Water Resource Center at (202) 566-1736.

Low Impact Development: Taking Steps to Protect New Hampshire's Surface Waters, DES fact sheet WD-WMB-17, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-17.pdf.

*NH Stormwater Management Manual Volume 1: Stormwater and Antidegradation, DES fact sheet WD-08-20A, (*603) 271-2975 or
http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20a.pdf

NH Stormwater Management Manual Volume 2: Post-Construction Best Management Practices Selection and Design, DES fact sheet WD-08-20B, *(*603) 271-2975 or
http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20b.pdf

NH Stormwater Management Manual Volume 3: Erosion and Sediment Controls During Construction, DES fact sheet WD-08-20C, *(*603) 271-2975 or
http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20c.pdf

Road Salt and Water Quality, DES fact sheet WD-WMB-4, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-4.pdf.

Shorelands Under the Jurisdiction of the Comprehensive Shoreland Protection Act, DES fact sheet SP-4, (603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/factsheets/sp/documents/sp-4.pdf.

Vegetation Maintenance Within the Protected Shoreland, DES fact sheet WD-SP-5, (603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/factsheets/sp/documents/sp-5.pdf